Development of an AUV-Fed Nearshore Nowcasting System

James M. Kaihatu
Code 7322, Oceanography Division
Naval Research Laboratory
Stennis Space Center, MS 39529-5004
phone: 228-688-5710   fax: 228-688-4759   email: kaihatu@nrlssc.navy.mil

K. Todd Holland
Code 7440.3, Marine Geosciences Division
Naval Research Laboratory
Stennis Space Center, MS 39529-5004
phone: 228-688-5320   fax: 228-688-4476   email: tholland@nrlssc.navy.mil

Brian S. Bourgeois
Code 7442, Marine Geosciences Division
Naval Research Laboratory
Stennis Space Center, MS 39529-5004
phone: 228-688-5321   fax: 228-688-4853   email: bsb@nrlssc.navy.mil

Richard A. Allard
Code 7322, Oceanography Division
Naval Research Laboratory
Stennis Space Center, MS 39529-5004
phone: 228-688-4894   fax: 228-688-4759   email: allard@nrlssc.navy.mil

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LONG-TERM GOAL

Our goal is the development of a nearshore nowcasting system that ingests nearshore data collected by an Autonomous Underwater Vehicle (AUV), or similar craft, and provides a nowcast of the nearshore waveheights and current fields for a potential amphibious landing site. The system will be incorporated into a real-time distributed database framework for initial condition specification and archiving of results.

OBJECTIVES

The basic scientific and technical objectives include the following:

- Develop an automated capability for processing initial conditions and environmental input (e.g., bathymetry) as measured by AUVs.
- Determine optimal space/time grid parameters to achieve balance between physical accuracy and computational speed.

- Evaluate data stream from AUVs and determine type, frequency and quality of data required for optimum model operation.
- Develop optimal method of merging on-scene data collections with model predictions, historical information or additional measurements to allow a more accurate nowcast.
- Facilitate the data-model communication and demonstrate system operation during a deployment exercise.

APPROACH

The approach pursued in this project involves the use of a sophisticated, comprehensive numerical model, in conjunction with bathymetry data from an AUV and a surf/wave/tide prediction system capable of linking to data servers for initial and environmental conditions. The numerical model, Delft-3D, is capable of simulating the propagation of nearshore waves and the resultant generation of wave-averaged nearshore currents (cross-shore and longshore currents). A morphology/sediment transport module is included to simulate the formation and movement of bathymetric features (e.g., sandbars, rip channels, etc.). The AUV systems, developed under other programs, are capable of obtaining data at high resolution, and can be used for measuring the necessary bathymetry for a given site. Our primary focus will be on using the REMUS vehicles, developed at Woods Hole Oceanographic Institution. For the purposes of this project, this data will be collected during various Fleet Battle Exercises (FBEs) and routine field testing. The prediction system, Distributed Integrated Ocean Prediction System (DIOPS), receives initial condition and environmental data from the Tactical Environmental Data server (TEDS), a primary source of METOC data. The present DIOPS system includes the Simulating Waves Nearshore (SWAN) wave model, the wave driver in Delft-3D. DIOPS will incorporate the hydrodynamic model FLOW, coupling it with SWAN to provide a 2-D surf prediction capability.

WORK COMPLETED

Funds were not received until January 2002; thus some of the work described in this section is still ongoing.

The REMUS vehicles were developed for purposes other than providing data for model initialization. For their intended purpose, a qualitative picture of the bathymetry was sufficient. Thus, much effort was expended in attempting to determine the nature and quality of the bathymetry data from the REMUS craft. A workshop was held at the Naval Oceanographic Office (NAVO) with representatives from NAVSEA to ascertain the quality of the data.

While we were unable as of yet to obtain access to the Delft-3D model, we were able to use an experimental version of the SHORECIRC model (Van Dongeren and Svendsen 2000), driven by the random wave model REF/DIF-S (Chawla et al. 1998), for our testing, expecting that the results of this testing would be applicable to the Delft-3D model. The initial testing consisted of comparison to data, with a subsequent systematic degradation of the resolution in order to determine a balance between model accuracy and computational speed.

As an additional interim measure, the demonstration version of Delft-3D was downloaded from the Delft web site. This was analyzed in order to ascertain the steps required to incorporate the code into the DIOPS system. Additionally, the Delft-3D User's Manuals were examined to learn more about the model and the tools available for grid setup.

To serve as a document of the nowcast system, a report has been prepared which details the individual elements: a short description of the phenomenology involved, available and necessary input information, useful output information, and available models with a brief discussion of their details.

RESULTS

In researching the REMUS data, it became clear that, instead of bathymetry, the craft measured "instantaneous water depth," filtering out neither tide nor wave motion. The NAVO workshop did not lead to a conclusive finding on the nature of processing of the data and how it can be transformed for our purposes in this project. This will be remedied when contact is made with the advanced users and developers of the REMUS system. In the interim, however, work has focused on learning more about the bathymetry data measured by the REMUS craft.

In the process of preparing our vision for a future operational nowcasting system, a wiring diagram for the system was developed; this is shown in Figure 1. This diagram details inputs, system elements and possible outputs, along with contingency measures should certain inputs not be available.
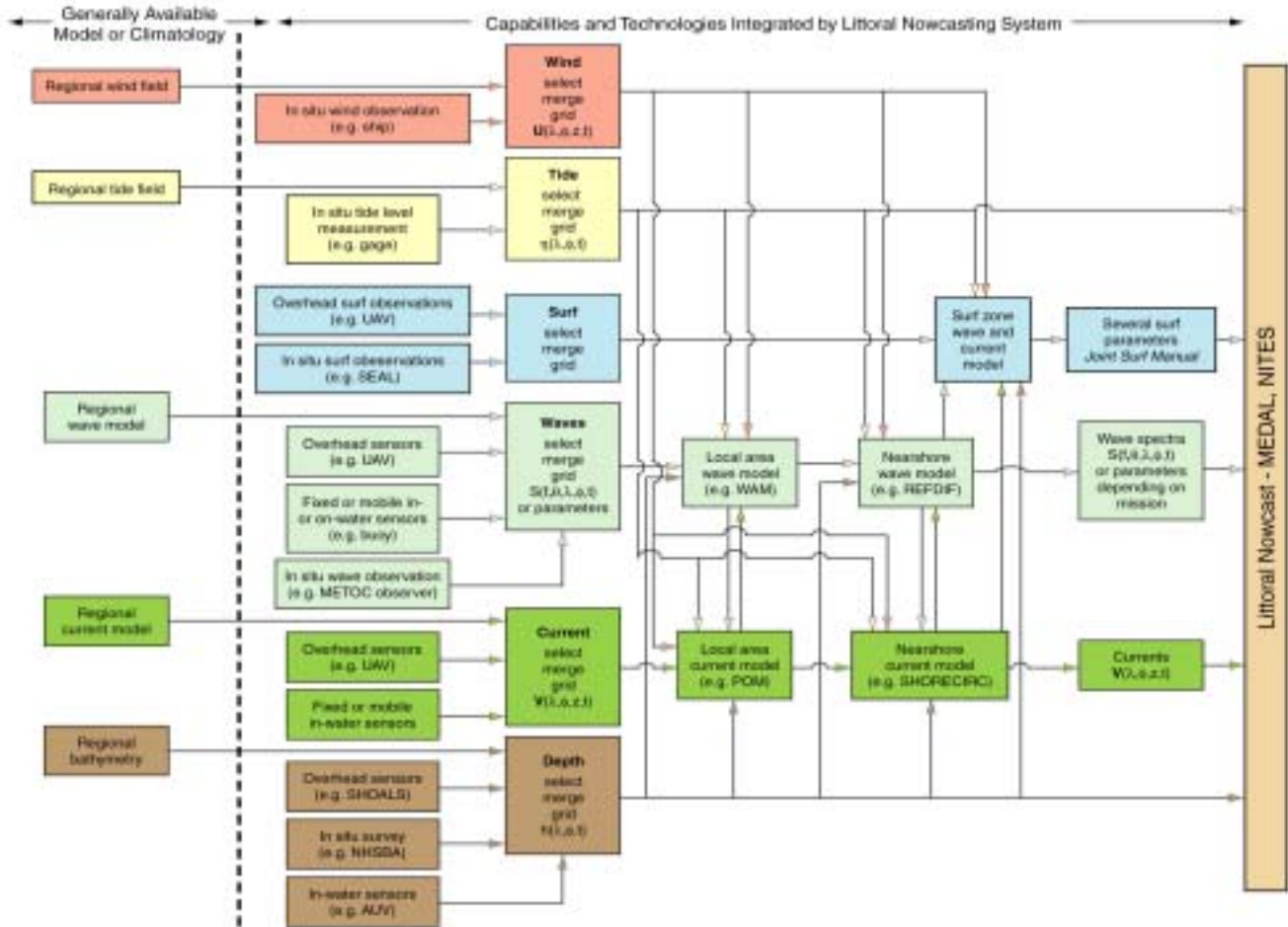
Figure 1: Wiring diagram for AUV-Fed Nowcasting System.

TRANSITIONS

Information gathered on the REMUS data has been transferred to NAVO.

RELATED PROJECTS

This project shares a close relationship with the NRL 6.2 Core project "Littoral Environment Nowcasting System (LENS)" (P.I.: Dr. K. Todd Holland), particularly in use of the bathymetric merging routines, numerical hydrodynamic models, and potential use of remote sensors for initial conditions. The project also relies on results from the National Ocean Partnership Program (NOPP) Nearshore Community Model (P.I.: Dr. J.T. Kirby, University of Delaware), especially the REF/DIF-S-driven SHORECIRC model.

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